Interactive Multi-scale Oil Paint Filtering on Mobile Devices

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Figure 1: *Results of the interactive multi-scale oil paint filtering approach that processes image pyramids and uses flow-based joint bilateral upsampling (FJBU) with the input image (left). Scale factors: 100% / full resolution without FJBU (middle), 33% / with FJBU (right).*

Abstract

This work presents an interactive mobile implementation of a filter that transforms images into an oil paint look. At this, a multi-scale approach that processes image pyramids is introduced that uses flow-based joint bilateral upsampling to achieve deliberate levels of abstraction at multiple scales and interactive frame rates. The approach facilitates the implementation of interactive tools that adjust the appearance of filtering effects at run-time, which is demonstrated by an on-screen painting interface for per-pixel parameterization that fosters the casual creativity of non-artists.

Keywords: oil paint filter, flow-based joint bilateral upsampling

Concepts: •**Computing methodologies** → **Image manipulation;**

1 Introduction and Motivation

Image stylization enjoys a growing popularity on mobile devices to foster casual creativity [Winnemöller 2013]. However, the implementation and provision of high-quality image effects for artistic rendering is still faced by the inherent limitations of mobile graphics hardware such as computing power and memory resources. In particular with the continuous advancements of mobile camera hardware, the interactive processing of high-resolution image data becomes an increasingly challenging task. This especially concerns image-based artistic rendering [Kyprianidis et al. 2013] that requires several passes of (non-)linear filtering. This work presents answers to these challenges by the example of an interactive oil paint filter. It demonstrates how complex nonlinear image filters can be efficiently processed on mobile GPUs, while providing fine-grained controls for high-level and low-level run-time parameterization to support the visual expression of non-artists—a contemporary field of research of the NPR community [Isenberg 2016].

2 Technical Approach

The mobile implementation of the oil paint filter is based on the work described in [Semmo et al. 2016], which requires wide kernels for Gaussian filtering ($\sigma \approx 20$) and leads to a high number of texture fetches to achieve firm color blendings—a performance limiting factor on mobile GPUs. Previous works typically employ separated filter kernels to alleviate this problem, but do not ultimately solve it for multi-stage and iterated nonlinear filtering.

The proposed solution is based on a multi-scale approach that operates on image pyramids and uses joint bilateral upsampling [Kopf et al. 2007] with the high-resolution input (Figure 1). At this, flow-based joint bilateral upsampling (*FJBU*) is proposed that uses the smoothed structure—adapted to the main feature contours of the filtered low-resolution image—to produce a painterly look. The FJBU uses a separable orientation-aligned implementation that filters in the gradient direction and along the flow curves induced by the tangent field. Together with real-time color grading using lookup tables, the enhancements enable interactive performance when processing input images with full HD resolution, and thus allow interactive per-pixel parameterizations via on-screen painting.

The filter was implemented using the OpenGL ES Shading Language and deployed on Android. For images with full HD resolution, it performs at 10 fps (scale factor 25%) and 6 fps (scale factor 50%) on a OnePlus Two with an Adreno 430 GPU. It is planned to make the oil paint filter publicly available as part of an app.

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References

ISENBERG, T. 2016. Interactive NPAR: What Type of Tools Should We Create? In *Proc. NPAR*, The Eurographics Association, Goslar, Germany, 89–96.

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ISBN: 978-1-4503-4371-8/16/07
DOI: http://dx.doi.org/10.1145/2945078.2945120

KOPF, J., COHEN, M. F., LISCHINSKI, D., AND UYTTENDAELE, M. 2007. Joint Bilateral Upsampling. *ACM Trans. Graph. 26*, 3.

KYPRIANIDIS, J. E., COLLOMOSSE, J., WANG, T., AND ISENBERG, T. 2013. State of the 'Art': A Taxonomy of Artistic Stylization Techniques for Images and Video. *IEEE Trans. Vis. Comput. Graphics 19*, 5, 866–885.

SEMMO, A., LIMBERGER, D., KYPRIANIDIS, J. E., AND DÖLLNER, J. 2016. Image Stylization by Interactive Oil Paint Filtering. *Computers & Graphics 55*, 157–171.

WINNEMÖLLER, H. 2013. NPR in the Wild. In *Image and Video-Based Artistic Stylisation*. Springer, 353–374.